

**RTCA Special Committee 186, Working Group 5**

**ADS-B UAT MOPS**

**Meeting #5**

**UAT Ground Uplink Message Format**

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**SUMMARY**

This paper addresses an Action Item 4-11 from meeting #4 to determine the format for ground uplink messages. Proposed new wording for MOPS section 2.2.3.2 is provided.

## Background

Due to changes in the UAT system designed to improve the robustness of the ground uplink messages, new formats for these messages need to be provided. The major changes from the “original” design based on 2xRS(255,235) include: (1) the elimination of the extra synchronization sequence in the middle of the message, (2) the addition of many more FEC parity symbols in a 6xRS(92,72) format, and (3) the elimination of CRC error-detection coding. Note that a RS(92,72) code has been chosen instead of the previously-discussed RS(85,65) coding. This change takes advantage of the possibility of reducing the guard time provided in the uplink architecture from the equivalent of 240 NM (for the RS(255,235) case) to the equivalent of 199 NM (for the RS(92,72) case). Thus, the throughput is reduced from the original 464 bytes per burst to 432 bytes per burst. The RS(85,65) alternative would have lowered the throughput to 390 bytes per burst. There is very little performance difference between the RS(92,72) code and the RS(85,65) code.

The remainder of this paper contains the suggested new wording.

## Specification Material

### 2.2.3.2 Ground Uplink Message Format

The ground uplink message format is shown in Figure 2-2. Each message element is described in detail in the subsections that follow.

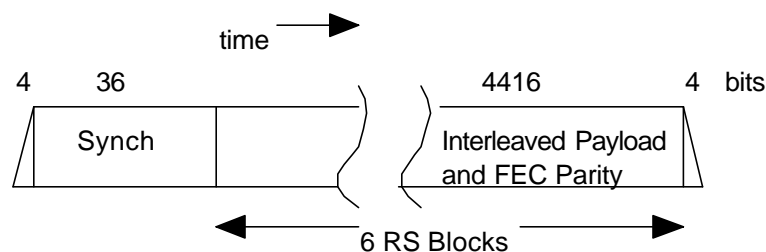


Figure 2-2. Ground Uplink Message Format

#### 2.2.3.2.1 Ramp Up/Down

To minimize transient spectral components, the transmitter power shall ramp up and down at the start and end of each burst. The maximum time duration of these ramps shall be no more than 4 bit periods each. Ramp up time is defined as the time between the transmitter “off” level to 90% power output. Ramp down time is defined as the time to decay from full power to –80 dBm at the antenna terminals. During ramp up and down, the modulating data shall be all zeroes.

### 2.2.3.2.2 Synchronization

Following ramp up, each data burst shall include a 36-bit synchronization sequence. For the ground uplink messages the polarity of the bits of the sequence is reversed from that used for the ADS-B messages, that is, the ones and zeroes are interchanged. This synchronization sequence shall be

000101010011001000100101101100011101,

with the leftmost bit transmitted first.

*NOTE: Because of the close relationship between the synchronization sequences used for the ADS-B and the ground uplink messages, the same correlator can search for them both simultaneously.*

### 2.2.3.2.3 Interleaved Payload/FEC Parity

The part of the burst labeled “Interleaved Payload and FEC Parity” in Figure 2-2 shall consist of 6 interleaved Reed-Solomon (RS) blocks. The RS coding shall be of the form RS(92,72), based on 8-bit symbols. The interleaver shall be represented by a 6 by 92 matrix, where each entry is a RS 8-bit symbol. Each row shall comprise a single RS(92,72) block as shown in Figure 2-3. The information shall be transmitted column by column, starting at the upper left corner of the matrix.

A1	A2	A3	...	A71	A72	PA1	...	PA19	PA20
B1	B2	B3	...	B71	B72	PB1	...	PB19	PB20
C1	C2	C3	...	C71	C72	PC1	...	PC19	PC20
D1	D2	D3	...	D71	D72	PD1	...	PD19	PD20
E1	E2	E3	...	E71	E72	PE1	...	PE19	PE20
F1	F2	F3	...	F71	F72	PF1	...	PF19	PF20

Figure 2-3. Ground Uplink Interleaver Matrix

*Note: In Figure 2-3, A1 through A72 are the 72 bytes (8 bits each) of payload information carried in the first RS(92,72) block. PA1 through PA20 are the 20 bytes of FEC parity associated with that block. The bytes are transmitted in the following order:*

*A1,B1,C1,D1,E1,F1,A2,B2,C2,D2,E2,F2,A3,..,PC20,PD20,PE20,PF20.*

*On reception these bytes must be deinterleaved so that the RS blocks can be reassembled prior to error correction decoding.*

#### 2.2.3.2.4 FEC Parity

The uplink information shall be encoded as a series of six RS(92,72) blocks. RS(92,72) is a systematic 256-ary code, with 72 bytes of information augmented by 20 bytes of parity. The primitive polynomial of the code shall be as follows:

$$p(x) = x^8 + x^7 + x^2 + x + 1.$$

The generator polynomial shall be as follows:

$$\prod_{i=120}^{139} (x - \mathbf{a}^i).$$

$\mathbf{a}$  is a primitive element of GF(256), and GF(256) is a Galois field of size 256.

*NOTE: This code is capable of correcting up to 10 symbol errors per block.*

#### 2.2.3.2.5 Payload

[TBP]